

# EFFECT OF HEAT ON THE CENTRIFUGAL SEDIMENTATION OF MILK SERUM PROTEINS

Some diversity of opinion exists among investigators regarding the effect of heat on the subsequent removal of the milk serum proteins by high-speed centrifugation. There appears to be agreement, however, that no significant amount of serum proteins in raw skim milk is removed by a centrifugal force of about 30,000 times gravity for periods of up to 1 hr. Ramsdell and Whittier (3) centrifuged heated and unheated skim milk for various periods of time in an air-driven, bowl-rotor ultracentrifuge (2), analyzed the supernatant liquid, and plotted the grams of acid-coagulable nitrogen per 100 g. of liquid against total nitrogen. They interpreted the parallelism of the lines for heated and unheated milk to mean "that no albumin or globulin was thrown out" under their conditions of centrifuging, and that "these whey proteins were not coagulated." The difference between the two lines was constant at about 0.09% nitrogen.

This represents the heat-denatured serum proteins, which are determined by the difference between the acid-precipitable fractions in heated and unheated milk. Since the heated sample is also centrifuged in these types of experiments, the data do not distinguish between serum proteins removed by acid coagulation and those removed by centrifugation. Thus, the parallelism of the lines for heated and unheated milks, obtained by plotting as described above, can not be used as a criterion of the removal of serum proteins from heated milk by centrifugation.

Early papers (1, 2, 3) have not reported the removal of enough nitrogen by centrifugation of heated samples to account for all of the casein, let alone the serum proteins. Recently, Sullivan *et al.* (4) have shown that a considerable quantity of the serum proteins is removed by high-speed centrifugation after heating to 200° F. for 1 min.

The data reported herein are compatible with Sullivan's results, in that they show the serum proteins to be rendered centrifugable by heating to 90° C. for 15 min.

Heated and unheated skim milks were centrifuged for 1 hr., using an average effective centrifugal force of 123,600 times gravity. The noncentrifuged samples and the supernatant portion of the centrifuged samples were analyzed for total nitrogen and acid-precipitable

nitrogen. The results, expressed as grams of nitrogen per 100 g. of liquid, are as follows:

| Noncentrifuged samples                            |          |             |
|---|----------|-------------|
| Component   | Raw milk | Heated milk |
| Total nitrogen                                    | 0.5830   | 0.5830      |
| Acid-precipitable nitrogen                        | 0.4480   | 0.5300      |
| Nonacid-precipitable nitrogen                     | 0.1350   | 0.0530      |
| Serum protein nitrogen (0.1350 - 0.0530) = 0.0820 |          |             |
| Centrifuged samples                               |          |             |
| Total nitrogen                                    | 0.1435   | 0.0794      |
| Acid-precipitable nitrogen                        | 0.0081   | 0.0264      |
| Nonacid-precipitable nitrogen                     | 0.1354   | 0.0530      |
| Serum protein nitrogen (0.1354 - 0.0530) = 0.0824 |          |             |

It is readily seen that the nonacid-precipitable fractions in raw and heated milks were different, but that they were not changed by centrifuging, remaining as 0.135% in the raw milk and 0.053% in the heated milk. The difference is 0.082%, representing the heat-denaturable serum protein fraction. However, the fact that this difference was constant before and after centrifuging does not indicate anything regarding the changes in serum protein brought about by heating. Only 0.0264 g. of acid-precipitable nitrogen per 100 g. of liquid remained in the heated sample after centrifuging. This shows that enough nitrogen was removed to account

$$\text{for } 68\% \left[ 100 \times \frac{0.082 - 0.0264}{0.082} \right] \text{ of the serum}$$

proteins, plus all of the casein. If some of the casein was noncentrifugable in the heated sample, then more than 68% of the serum protein was removed. Possibly, a longer centrifuging time would have removed an additional amount.

It is of interest to note that about 98%

$$\left[ 100 \times \frac{0.448 - 0.0081}{0.448} \right] \text{ of the casein in the raw}$$

milk was removed under these centrifugal conditions, whereas the serum proteins were unaffected.

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